

Studies of Acoustic and Microwave Surface Scattering in a Wavetank

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LONG-TERM GOALS

The long-term goal of this research is to understand both acoustic and microwave scattering from rough water surfaces sufficiently well to be able to implement operational models for wind speed prediction and, if possible, to remotely sense microscale breaking on the sea surface.

OBJECTIVES

Previous work that we carried out as part of the WAVES BAA program had shown the importance of bound, tilted Bragg scatterers in both microwave and acoustic scattering from rough water surfaces.

Our core scientific objective in this work was to elucidate the phenomenon of scattering from bound, tilted waves by making controlled wavetank measurements, and interpreting our results by way of improved theories.

APPROACH

Our approach is weighted heavily towards experiment. We have carried out a series of simultaneous acoustic and microwave rough surface scattering experiments in the wind-wavetank located at the University of Washington's Harris Hydraulic facility. Microwave and acoustic backscattered signals were obtained from the same spot, at the same time, at the same Bragg wavenumber.

WORK COMPLETED

Our first simultaneous measurements, made under the ONR Waves BAA program, were made at an acoustic frequency of 190 kHz, which roughly matches the wavelength of a Ka-band radar. For these measurements both sonar and radar looked upwind.

This year we expanded our measurement capability to include 70 kHz matching the wavelength of a Ku-band radar, and we completed a set of wavetank measurements with the radar looking upwind and the sonar looking both upwind and downwind.

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RESULTS

Figure 1 summarizes results. The top pair of plots show data from our 8 mm (or 190 kHz acoustic) measurement series. First, an experimentally satisfying result is shown by the right-hand figure: H-pol radar (cross marks) and acoustic (plus marks) cross sections are identical within our calibration uncertainty. Although simple Bragg scattering theory predicts this outcome, it has never been confirmed with measurement. (The V-pol radar measurements (circles) are above the H-pol as expected). The measurement configuration for the right-hand plot is such that both acoustic and microwave systems look in *opposite* directions but experience the *same* mean tilt angle imparted by the larger scale wind waves. The measurement configuration for the left-hand plot is such that both acoustic and microwave systems look in *same* directions but experience the *opposite* mean tilt angle (in sign).

These very intriguing results are consistent with scattering from bound, parasitic waves riding on the front face of (wind-generated) centimetric waves.

The bottom pair of plots in Fig. 1, represent the same measurement geometries but now done with our 70 kHz/ Ka-band system. Cross sections are matched on the right-hand plot, and they are offset in the left-hand plot, owing to the same tilt angle effect. However the scattering *level* differs between the two systems, which suggests that the wavenumber (K) spectral decay can not be assumed to be K^{-4}

We have documented this work in a paper entitled "Microwave and Acoustic Scattering from Parasitic Capillary Waves" which will be submitted soon for publication.

IMPACT / APPLICATIONS

Our results will be used to improve our ability to accurately model backscatter for operational purposes in both the acoustic and microwave cases.

TRANSITIONS

This work relates directly to other ONR programs (both 6.1 and 6.2) that involve frequencies in the > 10 kHz range, and scattering from the surface and near-surface bubble layer.

RELATED PROJECTS

This project is utilizing the results of previous measurement programs and is closely tied to a variety of programs supported by the Space and Remote Sensing Program at ONR, the Ocean Acoustics Program at ONR.

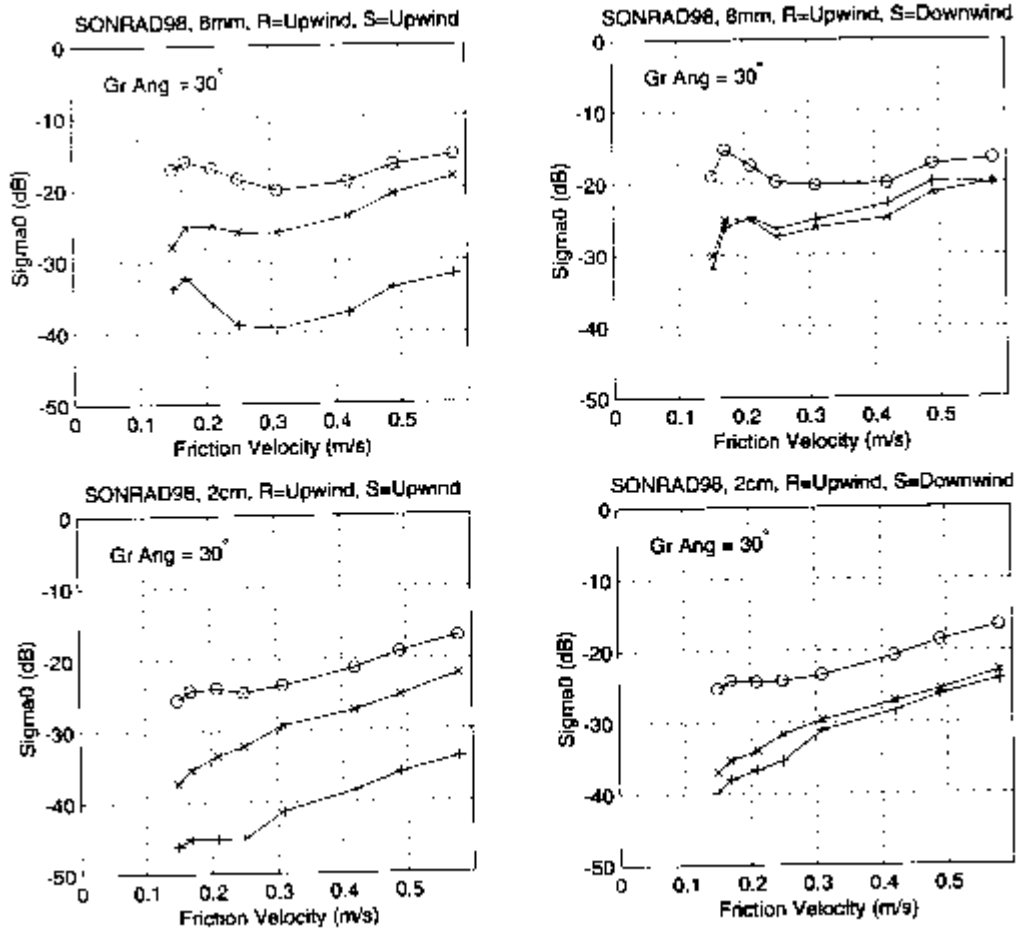


Figure 1 The top pair of plots show data from our 8 mm (or 190 kHz acoustic) measurement series: cross marks are H-pol radar data, plus marks are acoustic data, and circles are V-pol radar data. The measurement configuration for the right-hand plot is such that both acoustic and microwave systems look in opposite directions, and the measurement configuration for the left-hand plot is such that both acoustic and microwave systems look in the same direction. Bottom pair of plots shows same measurement series made with our 2 cm (or 70 kHz acoustic) system.